The contribution of foliar fungi to agricultural soil microbiomes in an organic cropping system

Derek Newberger* & Naupaka Zimmerman*
*Department of Biology, University of San Francisco

UNIVERSITY OF SAN FRANCISCO

Introduction

Cover cropping is an organic technique in which a non-commercial crop is grown for the benefits it provides to the soil. These benefits primary include nitrogen fixation (increasing soil nutrients without the addition of mineral fertilizers)[1] and contributing organic matter to the soil. In addition to these nutrient and structural benefits, **cover crops may also provide habitat for beneficial plant-associated microbes** that protect the crops subsequently grown in that location. **However, these microbial benefits can be difficult to quantify**, as they are the result of complex ecological interactions and are often not visually apparent[2]. **However, modern high-throughput sequencing technologies make quantifying these effects newly tractable.**

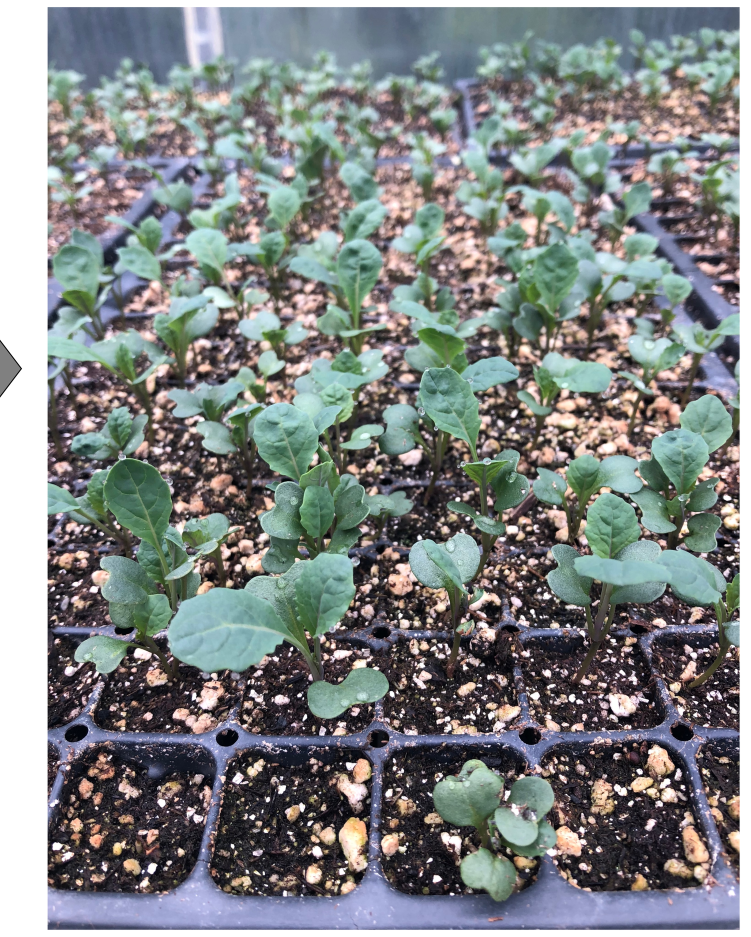
Thus, the overarching question I will answer, using a combination of field, greenhouse, and molecular analyses, is: ***How do cover crops influence the makeup of the soil fungal microbiome during organic crop rotations?***

To answer this question, I have partnered with one of California's oldest certified organic farms: Star Route Farms in Bolinas, CA. Each winter, Star Route grows cover crops (primarily Purple Vetch, *Vicia americana*) for nitrogen fixation. When the rains abate, cover crops are mowed, disced (6"), ripped, treated with compost, and re-disced. Seedlings are then transplanted onto the prepared field and harvested every 2–4 weeks. In a two part study, I will first quantify the *in situ* microbial communities in cover crop leaves and soil at two depths. Then, I will conduct a greenhouse experiment to test hypotheses about the mechanisms underlying the effects I observe.

Cover Cropping in Practice

Grow a cover crop like Purple Vetch (*Vicia americana*)

Incorporate cover crops with a rotary disc



Outplant and grow seedlings (clockwise from top right): Dinosaur Kale. Romaine Lettuce, Little Gem Lettuce

Harvest! Star Route Farm Stand in Bolinas, CA

Star Route Farms in Early December 2018

Methods

Three cash crops were chosen for this study: romaine lettuce (*Lactuca sativa*), which is of high economic importance; little gem lettuce (also *Lactuca sativa*), which is Star Route's most significant product; and dinosaur kale (*Brassica oleracea*), which is harvested for almost a year. Over 100m transects within soil previously used for each of the three crops (but all currently under vetch), I will obtain **10 sediment cores and 10 samples of cover crop leaf tissue**. Surface-sterilized and non-surface-sterilized leaf samples will be placed onto sterile malt extract agar, and any **emergent fungi will be isolated into pure cultures, vouchered, and barcode sequenced for identification purposes**. **Soil and leaf samples will be assessed for fungal community composition using high-throughput Illumina amplicon sequencing.**

At multiple sites along each transect, I will also collect 5 gallons of soil for subsequent experiments. At USF, I will conduct controlled, manipulative greenhouse experiments to help determine the mechanisms underlying any differences we find (*e.g.* communities could differ due to differences in nutrients, organic matter, or direct interactions between plant and soil microbial communities).

Acknowledgements

I would like to thank Annabelle Lenderink and Nick Civetz of Star Route Farms for frequent feedback and answers to my questions.

References

1. Van Der Heijden, M. G., Bardgett, R. D., & Van Straalen, N. M. (2008). The unseen majority: soil microbes as drivers of plant diversity and productivity in terrestrial ecosystems. *Ecology letters*, *11*(3), 296-310.
2. Voříšková, J., & Baldrian, P. (2013). Fungal community on decomposing leaf litter undergoes rapid successional changes. The ISME journal, 7(3), 477.